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# IMPACT OF EARLY TRACHEOSTOMY ON ICU STAY IN POSTOPERATIVE HEAD INJURY PATIENTS

General Surgery

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## ABSTRACT

**Background:** Postoperative head injury patients frequently require prolonged mechanical ventilation because of impaired neurological status and compromised airway protection. Early tracheostomy has been proposed to facilitate ventilator weaning, reduce intensive care unit (ICU) stay, and improve clinical outcomes; however, evidence from Indian tertiary care centres remains limited. **Objectives:** To evaluate the impact of early tracheostomy on ICU stay and related clinical outcomes in postoperative head injury patients. **Materials and Methods:** A prospective observational study was conducted on 50 postoperative head injury patients aged 18–60 years who underwent early tracheostomy within 72 hours of surgery at a tertiary care hospital. Clinical parameters including Glasgow Coma Scale (GCS), duration of mechanical ventilation, ICU stay, ventilator-associated pneumonia (VAP), and Glasgow Outcome Scale (GOS) at discharge were recorded. Data were analysed with appropriate statistical tests and $p<0.05$ was considered statistically significant. **Results:** Patients requiring ≤10 days of mechanical ventilation had a significantly shorter ICU stay (10.8±3.2 vs. 28.6±6.9 days; $p<0.001$) and a lower incidence of VAP (36% vs. 88%; $p<0.001$) than those requiring >10 days of ventilation. Better admission GCS patterns were significantly associated with shorter ventilatory duration ($p<0.001$). Neurological outcome at discharge was also significantly better in patients with shorter ventilatory support. Longer ventilation was associated with higher rates of vegetative state and death ($p<0.001$). **Conclusion:** Early tracheostomy was associated with reduced ICU stay, lower ventilator-associated pneumonia, shorter ventilatory support, and better neurological outcomes at discharge. Admission neurological status was an important determinant of recovery, supporting early tracheostomy as an effective airway management strategy in appropriately selected postoperative head injury patients.

## KEYWORDS

Early Tracheostomy; Head Injury; Intensive Care Unit; Mechanical Ventilation; Glasgow Outcome Scale; Ventilator-Associated Pneumonia.

## INTRODUCTION

Traumatic head injury (THI) is one of the leading causes of mortality and long-term neurological disability worldwide, particularly among young adults in the economically productive age group. Although advances in neuroimaging, neurosurgical techniques, and intensive care have improved survival, postoperative patients with severe head injury frequently require prolonged mechanical ventilation because of impaired consciousness and loss of airway protective reflexes. Consequently, airway management has become a cornerstone of neurocritical care, directly influencing ventilator dependence, intensive care unit (ICU) stay, complications, and overall patient outcomes.[1]

Patients with severe traumatic head injury often remain intubated following surgery because of delayed neurological recovery and the anticipated need for prolonged ventilatory support. In such patients, prolonged endotracheal intubation is associated with ventilator-associated pneumonia, laryngeal injury, increased sedation requirements, impaired secretion clearance, and delayed neurological assessment, all of which may adversely affect recovery and prolong ICU stay.[2]

Tracheostomy has emerged as an effective alternative airway strategy for patients requiring prolonged ventilation. By reducing airway resistance, facilitating pulmonary toileting, improving patient comfort, and enabling earlier ventilator weaning, tracheostomy may contribute to improved respiratory management and more efficient utilization of ICU resources. Prospective studies conducted in operated severe head injury patients have demonstrated favourable clinical outcomes following early tracheostomy, particularly with respect to ventilator duration and ICU stay.[3] In the Indian setting, comparative studies have also reported reductions in ICU stay, nosocomial pneumonia, and airway-related complications following early tracheostomy when compared with delayed intervention.[4]

The optimal timing of tracheostomy, however, remains controversial. Multicentre cohort studies have suggested that early tracheostomy is associated with improved ventilator-related outcomes without a significant effect on mortality.[5] Similar observations have been reported in neurosurgical intensive care units, where early tracheostomy has been shown to improve respiratory management without increasing procedure-related complications.[6] Recent systematic reviews and meta-analyses further support reductions in mechanical ventilation duration and ICU length of stay, although survival benefits remain inconsistent across studies.[7-8] Randomized evidence likewise indicates improved ICU efficiency with early tracheostomy while emphasizing the importance of careful patient selection.[9] Contemporary investigations continue to evaluate the influence of tracheostomy timing on critical care outcomes across different healthcare settings.[10-11] Therefore, the present study was undertaken to evaluate the impact of early tracheostomy on ICU stay and related clinical outcomes in postoperative head injury patients managed at a tertiary care centre.

## MATERIAL AND METHODS

**Study Design:** A prospective observational hospital-based study was conducted to evaluate the impact of early tracheostomy on ICU stay and related clinical outcomes in postoperative head injury patients.
**Study Setting:** The study was conducted in the Department of General Surgery in collaboration with the Department of Neurosurgery and Neuro-Intensive Care Unit at Subharti Medical College and Associated Hospital, Meerut, Uttar Pradesh, India, over a period of 18 months.
**Study Population:** The study included postoperative head injury patients aged 18–60 years requiring prolonged mechanical ventilation and undergoing early tracheostomy within 72 hours of surgery.
**Sample Size:** A total of 50 patients under Inclusion Criteria were enrolled.

### Inclusion Criteria

- Age 18–60 years.
- Postoperative head injury requiring mechanical ventilation.

- Early tracheostomy within 72 hours of surgery.
- Written informed consent from the patient or legally authorized representative.

**Exclusion Criteria**

- Age <18 years or >60 years.
- Associated spinal cord injury.
- Brainstem injury on CT/MRI.
- Diffuse cerebral edema or irreversible brain damage.
- ICU stay <72 hours or death within the first 72 hours.

**Data Collection and Investigations:** Clinical data were collected on a structured Case Record Form (CRF) . Patients underwent surgical or percutaneous tracheostomy as per institutional protocol. Data recorded were demographic details, Glasgow Coma Scale (GCS), ICU stay, ventilator days, ventilator free days, hospital stay, complications, mortality, treatment cost and Glasgow Outcome Scale (GOS) at discharge and 3 months. Investigations included CT brain, tracheal cultures (Day 0 and Day 7), chest X-ray and routine hematological and biochemical tests.

**Ethical Consideration:** The study was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants or their legally authorized representatives, and confidentiality was maintained throughout the study.

**Statistical Analysis:** The data were entered in Microsoft Excel and analyzed by using SPSS software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were expressed as frequency and percentage. The independent Student's t-test and Chi-square test were applied as appropriate. A p-value <0.05 was considered statistically significant.

## RESULTS

**Table 1: Age Distribution of Patients**

| Age Group (Years) | Number of Patients (n) | Percentage (%) |
|---|---|---|
| ≤20 | 5 | 10% |
| 21–30 | 18 | 36% |
| 31–40 | 11 | 22% |
| 41–50 | 10 | 20% |
| 51–60 | 6 | 12% |
| Total | 50 | 100% |

Table 1 shows the age distribution of the study population. Most of the patients were in the age group of 21-30 years (36%) followed by 31-40 years (22%) and 41-50 years (20%). Patients in the age groups of ≤20 years and 51-60 years constituted 10% and 12% respectively indicating the predominance of young adults.

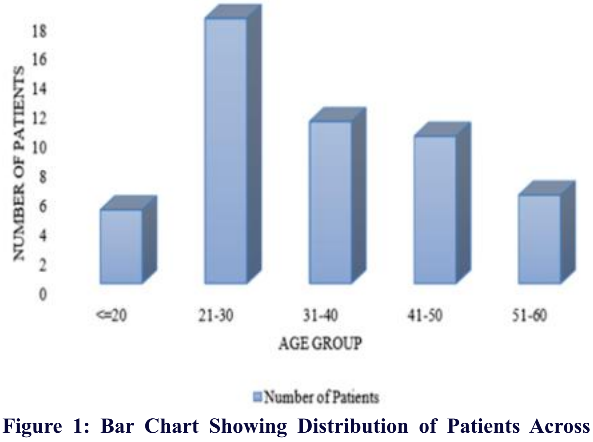


**Figure 1: Bar Chart Showing Distribution of Patients Across Different Age Groups**

**Table 2: Gender Distribution of Patients**

| Gender | Number of Patients (n) | Percentage (%) |
|---|---|---|
| Male | 43 | 86% |
| Female | 7 | 14% |
| Total | 50 | 100% |

Table 2 presents the gender distribution of the study population. Of the 50 patients included, 43 (86%) were male and 7 (14%) were female, demonstrating a marked male predominance. This finding reflects the higher incidence of severe head injury among males in the economically active age group.

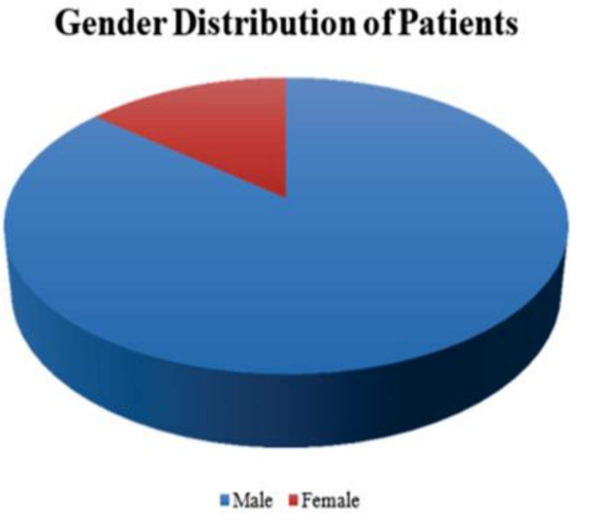


**Figure 2: Pie Chart Illustrating Gender Distribution of the Study Population**

**Table 3: Comparison of Admission GCS Pattern Between Ventilation Groups**

| GCS Pattern | ≤10 Days (n=25) | >10 Days (n=25) | Total | p-value |
|---|---|---|---|---|
| E1V1M2 | 0 | 12 | 12 | |
| E1V1M3 | 0 | 13 | 13 | |
| E2V2M5 | 13 | 0 | 13 | |
| E3V4M5 | 12 | 0 | 12 | |
| Total | 25 | 25 | 50 | <0.001 |

Statistically significant association

Table 3 compares the admission Glasgow Coma Scale (GCS) patterns between the two ventilation groups. Patients who required >10 days of mechanical ventilation had predominant E1V1M2 and E1V1M3 scores; those who were ventilated for ≤10 days had predominant E2V2M5 and E3V4M5 patterns; and these two groups showed a statistically significant association (p<0.001).

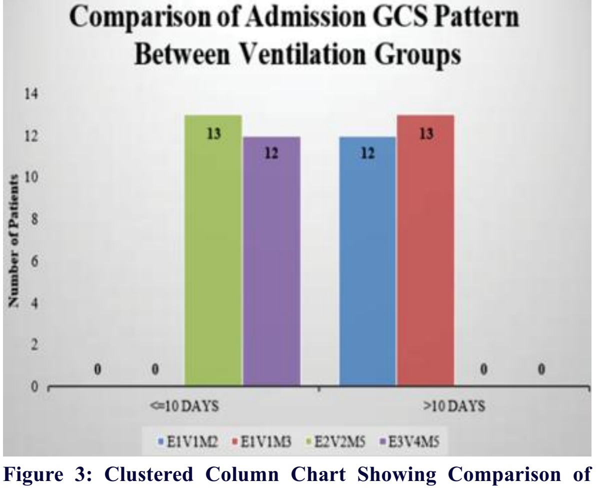


**Figure 3: Clustered Column Chart Showing Comparison of Admission GCS Patterns Between Patients with Ventilator Duration ≤10 Days and >10 Days**

**Table 4: Comparison of ICU Length of Stay Between Ventilation Groups**

| Parameter | ≤10 Days (n=25) | >10 Days (n=25) | p-value |
|---|---|---|---|
| Mean ICU Stay (Days) | 10.8 ± 3.2 | 28.6 ± 6.9 | <0.001 |
| Range (Days) | 5–15 | 16–37 | |

Result: Highly statistically significant

Table 4 compares the ICU length of stay between the two ventilation groups. Patients requiring ≤10 days of mechanical ventilation had a significantly shorter mean ICU stay (10.8 ± 3.2 days) than those requiring >10 days (28.6 ± 6.9 days), with the difference being highly statistically significant (*p*<0.001).

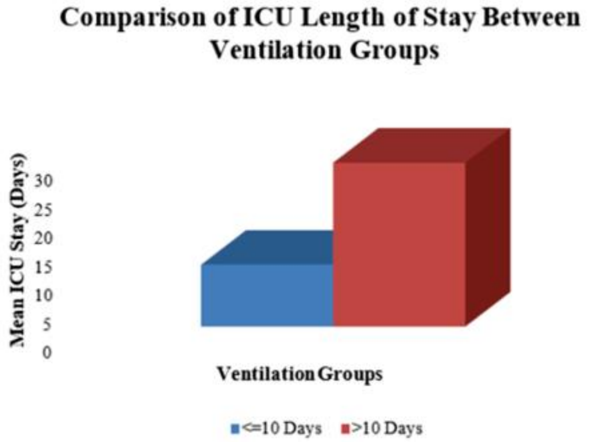


**Figure 4: Column Chart with Error Bars Showing Comparison of Mean ICU Length of Stay Between Patients with Ventilator Duration ≤10 Days and >10 Days, Demonstrating a Highly Statistically Significant Difference Between the Groups (p < 0.001)**

**Table 5: Comparison of Ventilator-Associated Pneumonia Between Groups**

| VAP Status | ≤10 Days (n=25) | >10 Days (n=25) | Total | p-value |
|---|---|---|---|---|
| Present | 9 | 22 | 31 | |
| Absent | 16 | 3 | 19 | |
| Total | 25 | 25 | 50 | <0.001 |

Result: Statistically significant

Table 5 compares the incidence of ventilator-associated pneumonia (VAP) between the two ventilation groups. VAP was observed in 22 (88%) patients requiring >10 days of mechanical ventilation compared with 9 (36%) patients ventilated for ≤10 days, demonstrating a statistically significant association (*p*<0.001).

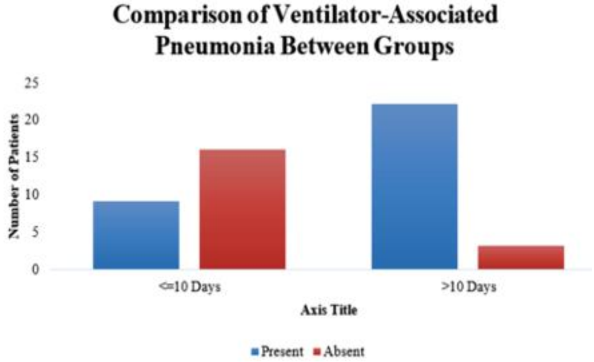


**Figure 5: Clustered Column Chart Showing Comparison of Ventilator-associated Pneumonia Between Patients With Ventilator Duration ≤10 Days and >10 Days, Demonstrating a Statistically Significant Higher Incidence of VAP in the Prolonged Ventilation Group (p < 0.001)**

**Table 6: Comparison of GOS at Discharge Between Ventilation Groups**

| GOS Score | Outcome Category | ≤10 Days (n=25) | >10 Days (n=25) | Total | p-value |
|---|---|---|---|---|---|
| 1 | Death | 0 | 4 | 4 | |
| 2 | Vegetative | 0 | 10 | 10 | |
| 3 | Severe Disability | 11 | 6 | 17 | |
| 4 | Moderate Disability | 14 | 5 | 19 | |
| 5 | Good Recovery | 0 | 0 | 0 | |
| Total | | 25 | 25 | 50 | <0.001 |

Result: Highly statistically significant

Table 6 compares the Glasgow Outcome Scale (GOS) at discharge between the two ventilation groups. Patients ventilated for ≤10 days predominantly had moderate (56%) or severe disability (44%), whereas the >10 days group showed higher rates of death (16%) and vegetative state (40%), indicating significantly poorer neurological outcomes (*p*<0.001).

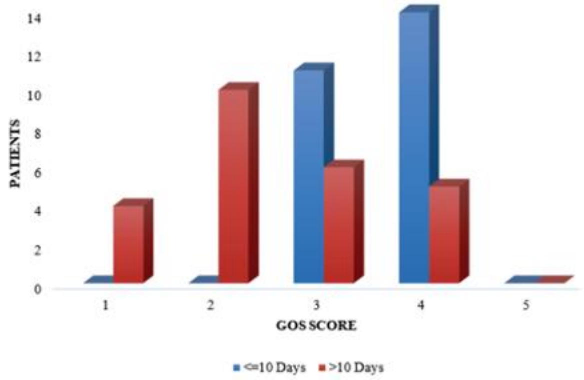


**Figure 6: Clustered Column Chart Showing Comparison of Glasgow Outcome Scale (GOS) at Discharge Between Patients with Ventilator Duration ≤10 Days and >10 Days, Demonstrating Significantly Poorer Outcomes in the Prolonged Ventilation Group (p < 0.001)**

## DISCUSSION

The maximum number of patients belonged to the 21–30 years age group (18 patients; 36%), followed by 31–40 years (11; 22%), 41–50 years (10; 20%), 51–60 years (6; 12%), and ≤20 years (5; 10%), which showed that young adults constituted the largest proportion of patients undergoing early tracheostomy following postoperative head injury. Similar findings were reported by Bharti et al. (2021)[3] with mean age of 43.4±14.5 years and most of the patients belonging to the economically productive age group. Robba et al (2020)[1], Zahari et al (2022)[6] and Villemure-Poliquin et al (2023)[8] also showed that traumatic brain damage mainly affected younger and middle-aged persons requiring prolonged ventilatory support. Unlike these publications, the age distribution was reported in categorical age-groups, which showed the predominance of patients between 21 and 30 years of age.

The sample population consisted of 43 males (86%) and 7 females (14%) showing a pronounced male predominance with an approximate male to female ratio of 6:1. This distribution is in keeping with the epidemiological trend of traumatic brain injury, where males are more often exposed to road traffic accidents and industrial injuries. Similar observations were reported by Bharti et al (2021)[3], Robba et al (2020)[1] and Zahari et al (2022)[6]. Blackwell et al (2024)[11] reported a much higher proportion of male patients tracheostomized after severe traumatic brain injury. These studies similarly demonstrated male predominance, but the exact proportion differed between institutions and populations due to differences in referral patterns, injury etiology and area demography.

Among the patients requiring ≤10 days of mechanical breathing, 13 had an entrance GCS pattern of E2V2M5 and 12 patients had E3V4M5. All patients requiring >10 days of ventilation had more severe neurological impairment, including 12 patients with E1V1M2 and 13 with E1V1M3. This association between the pattern of GCS on entry and duration of ventilation was statistically significant (p<0.001) and suggested deterioration in neurological status was associated with prolonged ventilatory support. Similar findings were reported by Robba et al. 2020[1] who found GCS ≤8 to be a significant predictor for tracheostomy . Tanaka et al (2022)[5] also found poor outcome in patients with depressed consciousness. In contrast to these investigations, neurological severity was defined based on specific GCS patterns rather than broader GCS score categories, providing a more in-depth assessment of entrance neurological status.

Patients requiring ≤10 days of mechanical ventilation had a mean ICU stay of 10.8 ± 3.2 days (range 5–15 days) compared with a much longer mean ICU stay of 28.6 ± 6.9 days (range 16–37 days) for those requiring >10 days with a very significant difference (p<0.001). Similar results were reported by de Franca et al (2020)[2], Bharti et al (2021) [3], Zahari et al (2022) [6]and Bertini et al. (2023) [7] reported shorter stay in ICU after early tracheostomy. ICU LOS was significantly shorter in early tracheostomy group (17±3 vs 30±11 days) (Benabdelouahab et al. 2024 [10]) Shah et al. (2022)[4] reported no significant difference in between the early and late tracheostomy groups with lesser airway related problems.

Ventilator associated pneumonia (VAP) was seen in 31 patients (62%) while 19 patients (38%) were infection free. VAP formed in 9 (36%) of the patients who required ≤10 days of mechanical ventilation and did not develop in 16 (64%). However, VAP developed in 22 (88%) of the patients who required >10 days of mechanical ventilation and only 3 (12%) remained free of infection which was statistically significant ($p<0.001$). Similar results were observed in the studies performed by de Franca et al (2020)[2], Shah et al (2022)[4], Bertini et al (2023)[7] and Bharti et al (2021)[3] who observed less incidence of pulmonary infection problems in the early tracheostomy group. In contrast, Merola et al. (2024)[9] and Benabdelouahab et al (2024)[10] observed no significant reduction in ventilator-associated pneumonia despite the benefits of earlier tracheostomy.

Four patients (8%) died at discharge (GOS 1) ten (20%) were in a vegetative state (GOS 2), seventeen (34%) had severe disability (GOS 3) and nineteen (38%) had moderate disability (GOS 4) and no patient had a successful recovery (GOS 5). Neurological outcome was better in patients ventilated for ≤10 days. Fourteen (56%) had moderate disability and 11 (44%) had severe disability. In the >10 days group there were 4 deaths (16%), 10 vegetative patients (40%), 6 (24%) with severe disability and 5 (20%) with moderate disability ($p<0.001$). Similar findings were reported by Robba et al (2020)[1], Tanaka et al (2022)[5], Villemure-Poliquin et al (2023)[8] and Blackwell et al. (2024)[11] who linked earlier tracheostomy to improved neurological or survival outcomes. On the other hand, de Franca et al (2020)[2] and Bertini et al (2023)[7] demonstrated better results connected to ICU, but without significant reduction in mortality.

## CONCLUSION

Early tracheostomy in postoperative head injury patients requiring prolonged mechanical ventilation was associated with favorable critical care outcomes especially in reducing ICU stay, limiting prolonged ventilator dependence and improving neurological recovery at discharge. Patients with better neurological status on admission required shorter ventilatory support and resulted in significantly less ICU utilization while prolonged mechanical ventilation was associated with a higher incidence of ventilator associated pneumonia and a poorer Glasgow Outcome Scale score. Radiological severity alone did not influence the duration of ventilatory support but clinical neurological status appeared to be a better predictor of recovery and ICU course. These findings favor the role of early tracheostomy as an effective airway management strategy that facilitates earlier ventilator weaning, optimizes ICU resource utilization, reduces respiratory complications and contributes to improved short-term functional outcomes in appropriately selected postoperative head injury patients under intensive care management.

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